"1/4"

1V—

...                    ...

0.25 MS →

1 MS

*Fig.1A*

"2/4"

1V—

...                    ...

0.5 MS →

1 MS

*Fig.1B*

"3/4"

1V—

...                    ...

0.75 MS →
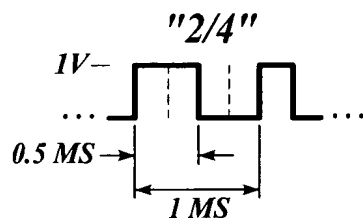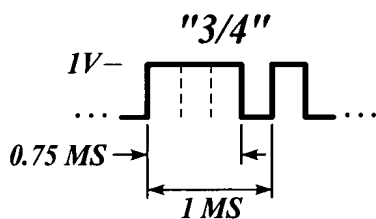
1 MS
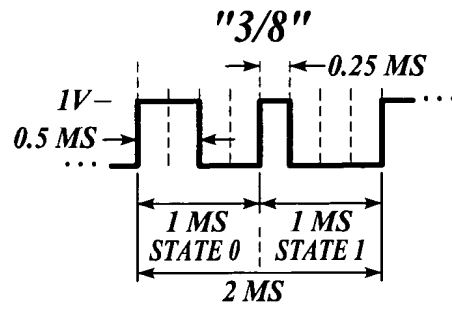
*Fig.1C*

*Fig. 2*

| NUMBER OF UNIT PULSE LENGTHS | MODULATOR BINARY OUTPUT COMBINATIONS | TIMER STATE | EFFECTIVE DUTY CYCLE |
|---|---|---|---|
| *0* | *0 0*<br>*0 0* | *0*<br>*1* | *= 0%  (0/8)* |
| | *0 0*<br>*0 0* | *0*<br>*1* | |
| *1* | *0 0*<br>*0 1* | *0*<br>*1* | *= 12.5%  (1/8)* |
| | *0 1*<br>*0 0* | *0*<br>*1* | |
| *2* | *0 1*<br>*0 1* | *0*<br>*1* | *= 25%  (2/8 = 1/4)* |
| | *0 1*<br>*0 1* | *0*<br>*1* | |
| | *0 0*<br>*1 0* | *0*<br>*1* | |
| | *1 0*<br>*0 0* | *0*<br>*1* | |
| *3* | *0 0*<br>*1 1* | *0*<br>*1* | *= 37.5%  (3/8)* |
| | *1 1*<br>*0 0* | *0*<br>*1* | |
| | *0 1*<br>*1 0* | *0*<br>*1* | |
| | *1 0*<br>*0 1* | *0*<br>*1* | |
| *4* | *0 1*<br>*1 1* | *0*<br>*1* | *= 50%  (4/8 = 1/2)* |
| | *1 1*<br>*0 1* | *0*<br>*1* | |
| | *1 0*<br>*1 0* | *0*<br>*1* | |
| | *1 0*<br>*1 0* | *0*<br>*1* | |
| *5* | *1 0*<br>*1 1* | *0*<br>*1* | *= 62.5%  (5/8)* |
| | *1 1*<br>*1 0* | *0*<br>*1* | |
| *6* | *1 1*<br>*1 1* | *0*<br>*1* | *= 75%  (6/8 = 3/4)* |
| | *1 1*<br>*1 1* | *0*<br>*1* | |

*Fig.3A*



*Fig.3B*

* INDICATES OVERFLOW BIT

| DUTY CYCLE | POSSIBLE MODULATOR BINARY OUTPUT COMBINATIONS | TIMER STATE |
|---|---|---|
| 0% (0/8) | 0 0 | 0 |
| | 0 0 | 1 |
| 12.5% (1/8) | 0 1 | 0 |
| | 0 0 | 1 |
| | 0 0 | 0 |
| | 0 1 | 1 |
| 25% (2/8) | 0 0 | 0 |
| | 1 0 | 1 |
| | 1 0 | 0 |
| | 0 0 | 1 |
| | 0 1 | 0 |
| | 0 1 | 1 |
| 37.5% (3/8) | 0 0 | 0 |
| | 1 1 | 1 |
| | 1 1 | 0 |
| | 0 0 | 1 |
| | 0 1 | 0 |
| | 1 0 | 1 |
| | 1 0 | 0 |
| | 0 1 | 1 |
| 50% (4/8) | 0 0 | 0 |
| | 1* 00 | 1 |
| | 1* 00 | 0 |
| | 0 0 | 1 |
| | 0 1 | 0 |
| | 1 1 | 1 |
| | 1 1 | 0 |
| | 0 1 | 1 |
| | 1 0 | 0 |
| | 1 0 | 1 |
| 62.5% (5/8) | 0 1 | 0 |
| | 1* 00 | 1 |
| | 1* 00 | 0 |
| | 0 1 | 1 |
| | 1 1 | 0 |
| | 1 0 | 1 |
| | 1 0 | 0 |
| | 1 1 | 1 |
| 75% (6/8) | 1* 00 | 0 |
| | 1 0 | 1 |
| | 1 0 | 0 |
| | 1* 00 | 1 |
| | 1 1 | 0 |
| | 1 1 | 1 |
| 87.5% (7/8) | 1* 00 | 0 |
| | 1 1 | 1 |
| | 1 1 | 0 |
| | 1* 00 | 1 |
| 100% (8/8) | 1* 00 | 0 |
| | 1* 00 | 1 |

*Fig.4*

1V

0.25 MS

1/32

| 1 MS | 2 MS | 3 MS | 4 MS | 5 MS | 6 MS | 7 MS | 8 MS |

STATE 0 | STATE 1 | STATE 2 | STATE 3 | STATE 4 | STATE 5 | STATE 6 | STATE 7

*Fig.5A*

1V

0.25 MS

1/64

| 1 MS | 2 MS | 3 MS | 4 MS | 5 MS | 6 MS | 7 MS | 8 MS | 9 MS | 10 MS | 11 MS | 12 MS | 13 MS | 14 MS | 15 MS | 16 MS |

STATE 0 | STATE 1 | STATE 2 | STATE 3 | STATE 4 | STATE 5 | STATE 6 | STATE 7 | STATE 8 | STATE 9 | STATE 10 | STATE 11 | STATE 12 | STATE 13 | STATE 14 | STATE 15
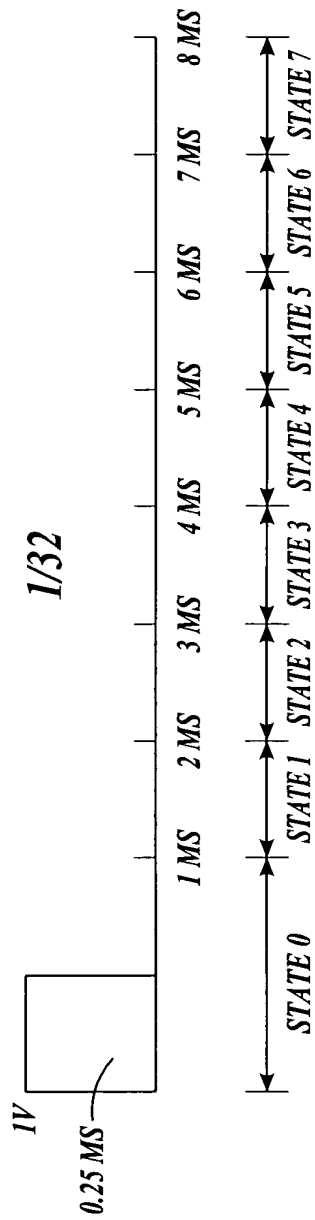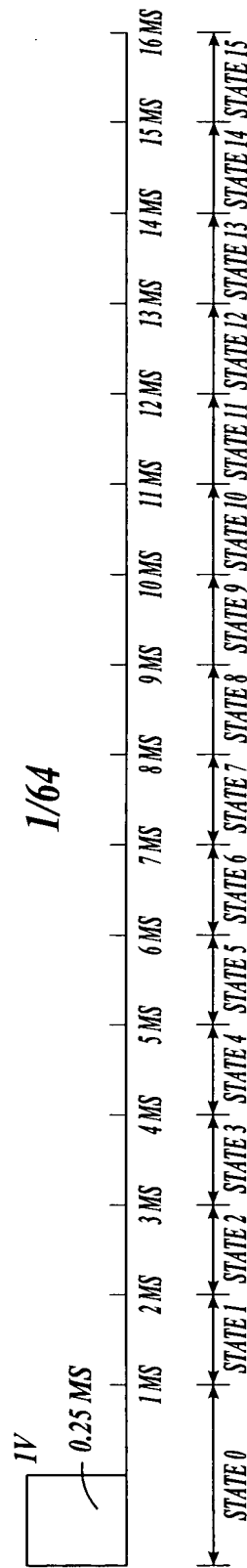
*Fig.5B*
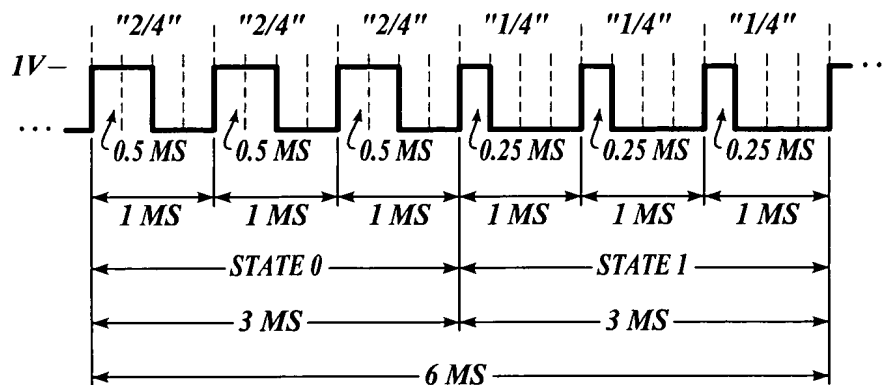
*Fig.6*
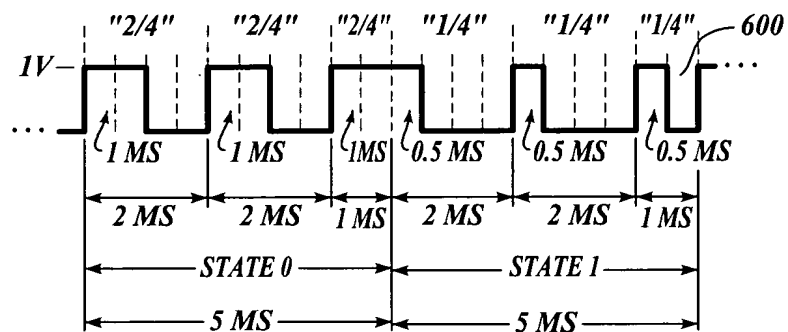


PWM PERIOD = 2 MS,  TIMER PERIOD = 5 MS

*Fig.7*

*Fig.8*

BEGIN → RECEIVE
n + log₂K
BIT SETTING — 700

702
IS SETTING
GREATER THAN
n + log₂K
BITS? — YES → LIMIT SETTING TO
n + log₂K BITS — 704

NO

FIGURE WHAT TIMER
STATE WE ARE IN — 706

SET MODULATOR MINIMUM
AND MAXIMUM VALUES
FOR THIS STATE — 709

STORE SETTING
INTO TEMP_SETTING

708

CORRECT STARTUP
PROBLEM WITH MIN_VALUE — 710

ADJUST SETTING WITH
OFFSET FROM MIN_VAL — 712

714
DOES
THIS STATE
NEED TO BE SET
AT 100% D.C.
? — YES → SET TO 100%
DUTY CYCLE — 716

NO

SET PWM TO APPROPRIATE
VALUE FOR THIS STATE — 718

TURN OFF 100%
DUTY CYCLE BIT — 720

INCREMENT
STATE COUNTER
FOR NEXT STATE — 722 → FINISH

| TOTAL PULSE DURATION AS MEASURED IN UNIT PULSE LENGTHS | MODULATOR OUTPUT IN EACH TIMER STATE | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | TIMER STATE | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 3 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 4 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 5 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 6 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 8 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 9 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 10 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| 11 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 |
| 12 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 |
| 13 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 1 |
| 14 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 1 |
| 15 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| 16 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 17 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 18 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| 19 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 |
| 20 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 |
| 21 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 |
| 22 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 |
| 23 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| 24 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| 2040 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| 2047 | 256 | 256 | 256 | 256 | 256 | 256 | 256 | 256 |

*Fig.9*

904a —
POWER
SUPPLY      +      CURRENT
LIMITER      — 906

918 —
CLOCK

910 —

LED
ARRAY      — 902

COMPUTING
DEVICE      PULSE
GENERATOR      BUFFER      DRIVER      — 912

920 —      916 —      908 —      — 904b

7

*Fig.10*